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MA ET AL.
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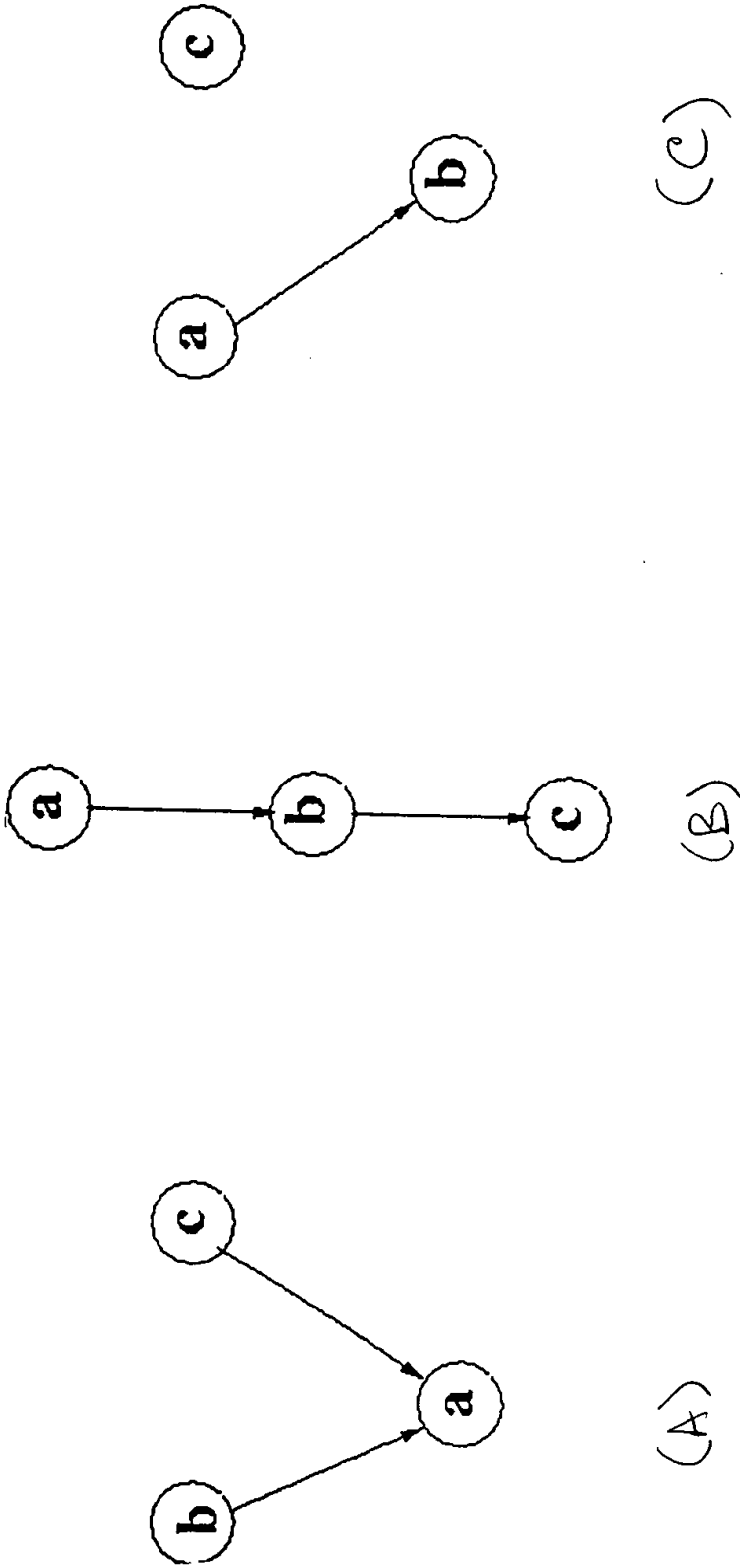


FIG. 1

T_1: {a, b, c, d, e, f, g}

T_2: {d, f, g}

T_3: {a, b, d, g}

T_4: {a, d, g}

T_5: {f, g}

T_6: {e, f}

T_7: {e}

T_8: {h, i}

T_9: {h, j}

T_10: {j}

102

PATTERNS	COUNT
a	3
b	2
c	1
d	4
e	3
f	4
g	5
h	2
i	1
j	2

104

PATTERNS	COUNT
ab	2
ad	3
ae	1
af	1
ag	3
.....	

106

Example for Dependency

{ag}: frequent, is not d-pattern with 95% confidence

$$p(a) = 3/10; p(g) = 5/10; p^* = 3/10 * 5/10 = 0.15$$

$$\text{minsup}(\{a, g\}) = 10 * 0.15 + 1.86 * \sqrt{10 * 0.15 * (1 - 0.15)} = 3.6$$

{ab}: is not frequent, but is d-pattern with 95% confidence

$$p(a) = 3/10, p(b) = 2/10, p^* = 2/10 * 3/10 = 0.06$$

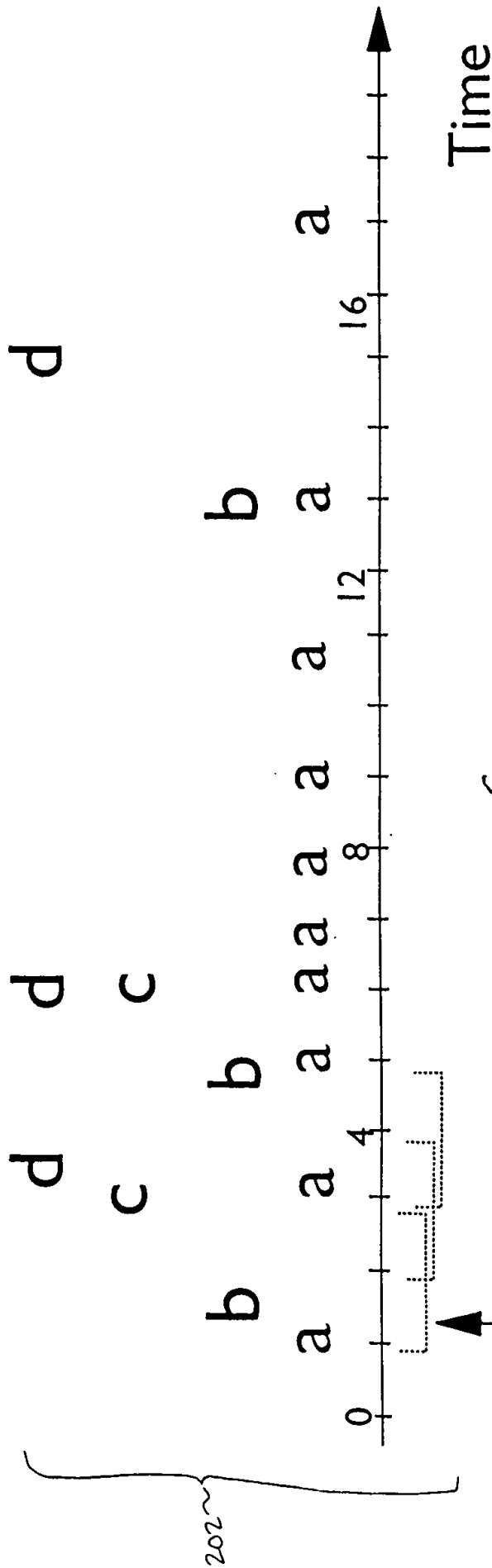
$$\text{minsup}(\{a, b\}) = 10 * 0.06 + 1.86 * \sqrt{10 * 0.06 * (1 - 0.06)} = 1.99$$

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FIG. 2A



Sliding window

Time

EXAMPLE FOR DEPENDENCY

TOTAL # OF SLIDING WINDOWS = 20

{ab}: frequent, but not d-pattern with 95% confidence

$$P(a) = 10/20; P(b) = 3/20; P^* = 10/20 * 3/20 = 0.075$$

$$\text{minsup}(\{ab\}) = 20 * 0.075 + 1.86 * \text{sqrt}(20 * 0.075 * (1 - 0.075)) = 3.69$$

{dc}: not frequent, but is d-pattern with 95% confidence

$$P(d) = 3/20; P(c) = 2/20; P^* = 3/20 * 2/20 = 0.015$$

$$\text{minsup}(\{dc\}) = 20 * 0.015 + 1.86 * \text{sqrt}(20 * 0.015 * (1 - 0.015)) = 1.3$$

208

Patterns Count

ab	3
ac	2
dc	2
....	

206

Patterns Count

a	10
b	3
c	2
d	3

204

FIG. 2B

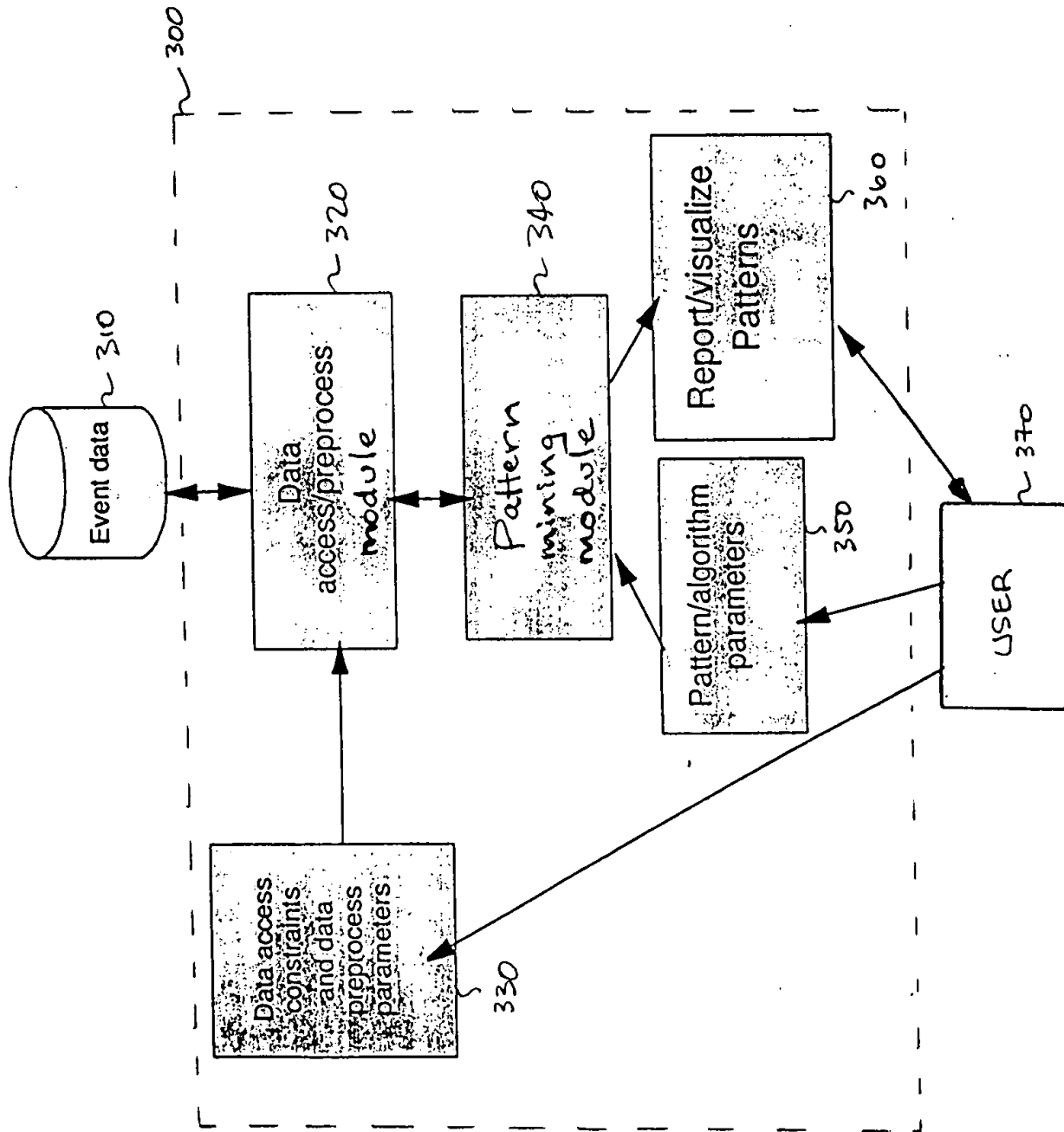
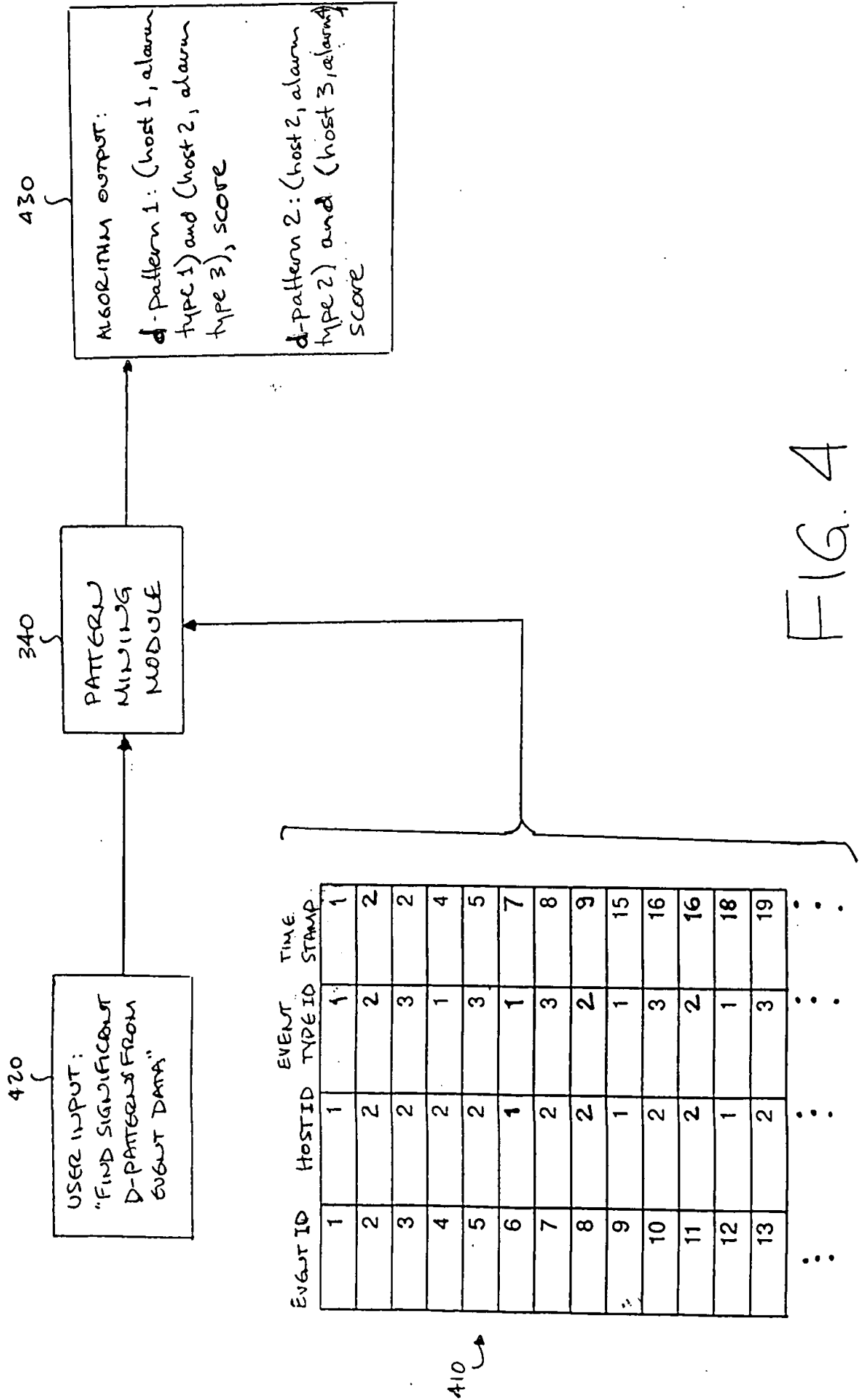


FIG. 3



500 ~

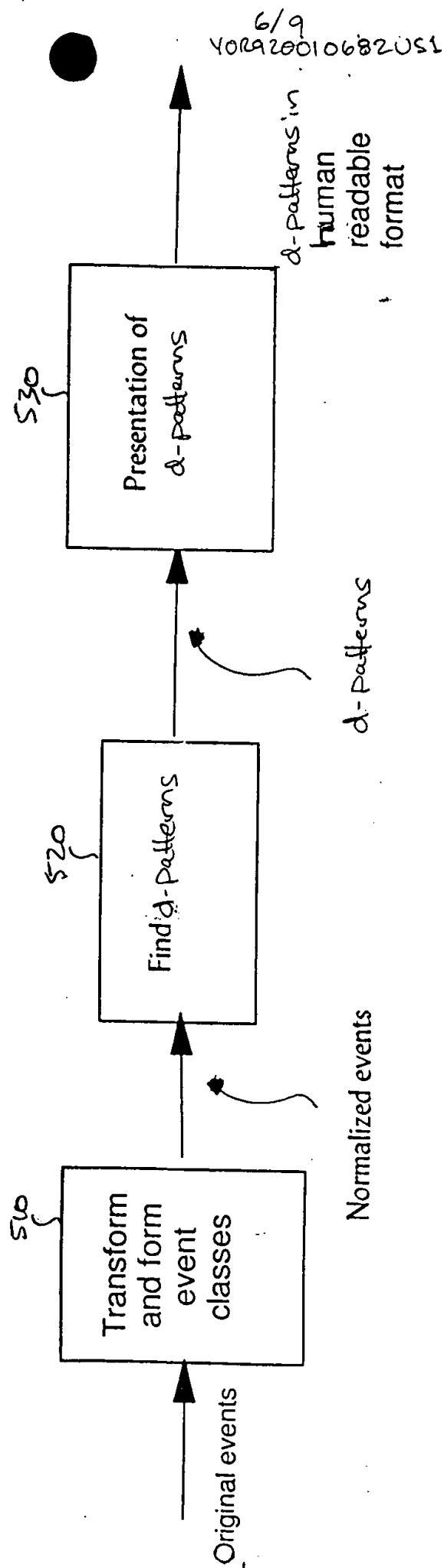
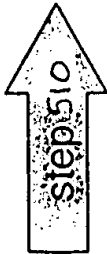


FIG. 5

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Event ID	Event type ID	Host ID	Time stamp
1	1	1	1
2	2	2	2
3	1	1	4
4	1	1	7
5	2	2	9
6	1	1	15
7	2	2	16
8	1	1	18
9	1	3	19
10	2	1	21
11	2	2	23
12	2	2	25
13	1	1	30

Table: original events



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{Event type ID, host ID}	Event class
{1, 1}	1
{1, 3}	2
{2, 1}	1
{2, 2}	4

Table: mapping for event class

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EVENT ID	EVENT CLASS	TIME Stamp
1	1	1
2	4	2
3	1	4
4	1	7
5	4	9
6	1	15
7	4	16
8	1	18
9	2	19
10	1	21
11	4	23
12	4	25
13	1	30

Table: event after mapping

FIG 6

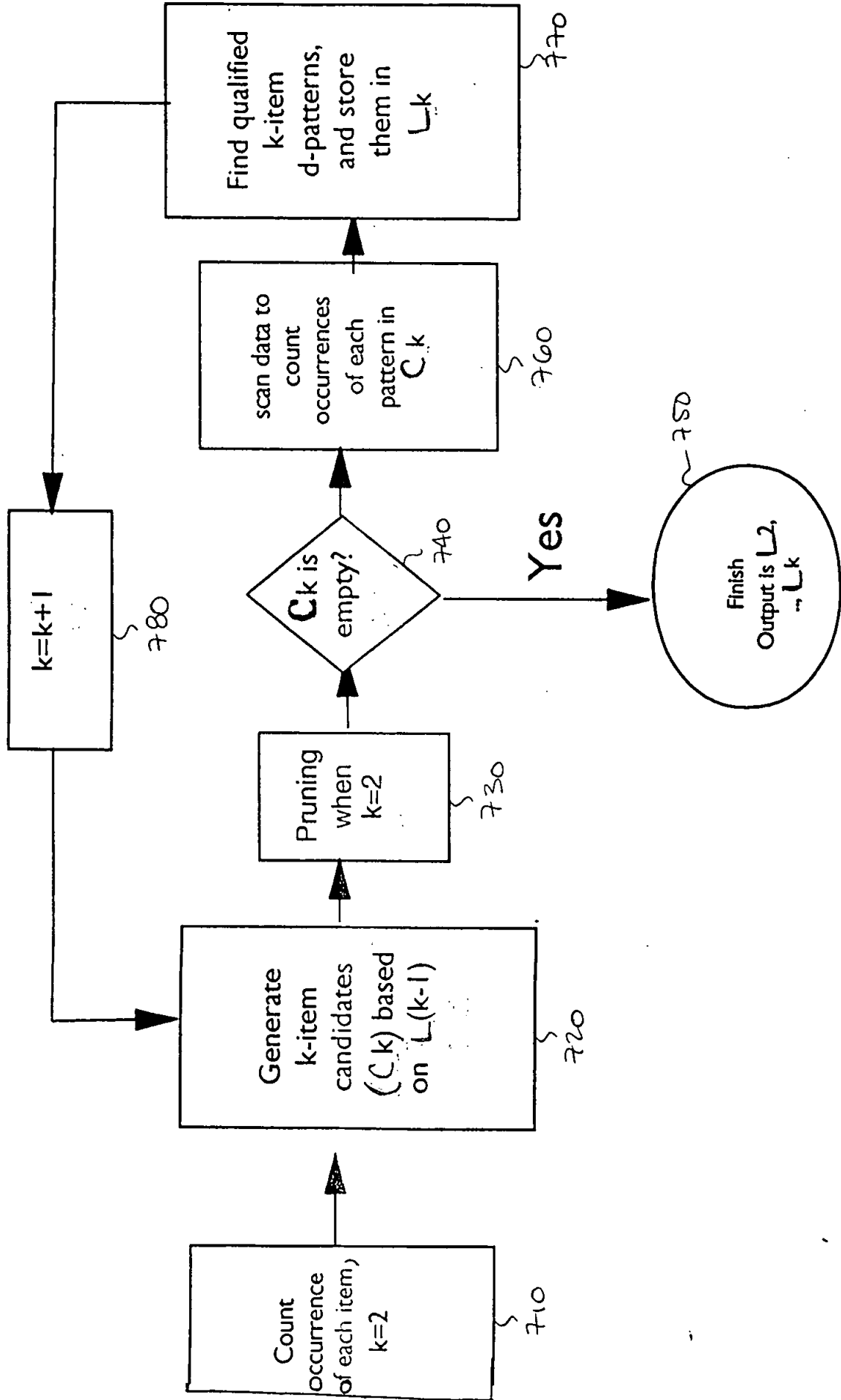


FIG. 7

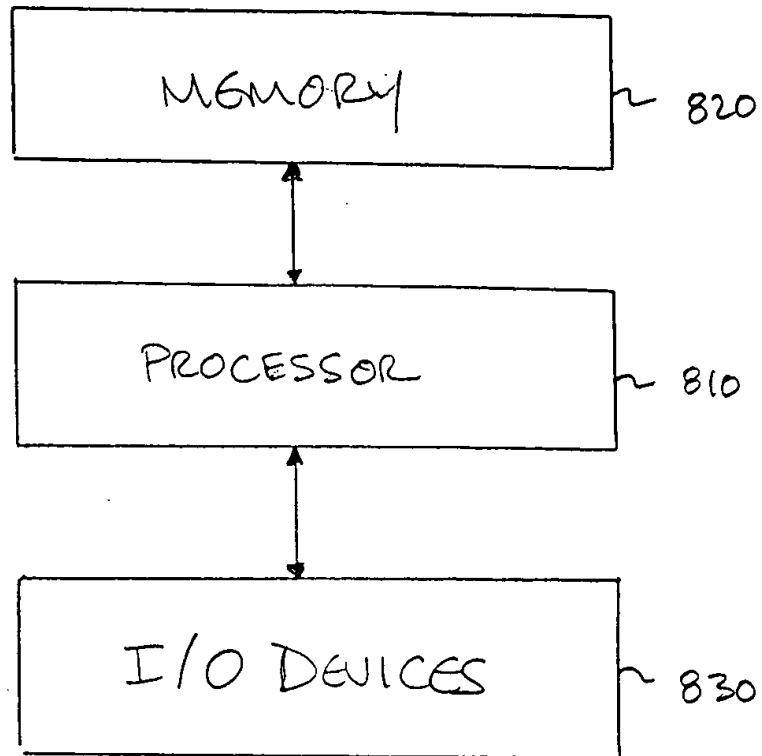


FIG. 8

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